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PUBLIC REACTION TO IMPOSED RISK

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ABSTRACT*

Implicit in every nonarbitrary government decision on the use of technology is a trade-off of a certain amount of risk in return for societal benefits. However, the assessment of this risk is often frustrated, not only by inadequate experience and by incomplete knowledge of the causality of environmental impacts, but also by a disparity between individual and societal views of risk. While the societal view is based on quantitative methods and objective risk functions, and on <u>net</u> societal benefit, individuals tend to rely on subjective judgment, and consider the distribution as well as the amount of benefit. The resultant biases in the way individuals perceive risk are key to the viability of any policy decision, and thus must be considered in determining the future course of research in risk assessment.

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INTRODUCTION

Every governmental action imposes a certain level of risk on certain individuals, in return for a presumably greater level of benefit to society. The risk may be direct to the individual, for example an increase in morbidity or mortality due, to say, to release of toxins into the air or water; or it may be indirect, such as damage to an ecosystem or change in the sociocultural makeup of a region. Obviously, for the government to discern the optimal tradeoff of risk and benefit from among its various options, it must in advance have some idea of the nature and probability of the consequences of each. Unfortunately, while in the past risk assessment has often been presented as a well-defined, objective exercise, in fact it is nothing of the sort, for several reasons:

No historical data exist for new technologies. Many public decisions in the field of energy involve new technologies, such as synfuels, for which an adequate sample of operating facilities does not exist; in many cases, none exist at all. In the absence of an historical data base, estimates of risk must be subjectively rather than objectively derived: in other words, expert intuition is used in lieu of actual experience. The credibility of such estimates is questionable at best; the nuclear controversy is a prime example of how diverse legitimate expert opinion can be (House, 1980).

The causal links between many direct impacts and their environmental consequences are not known. While the direct, first-order impacts of a given action can as a rule be described fairly certainly, the impacts they cause in turn are less and less understood the farther one moves along the causal network. In some areas (e.g. ecosystems), our knowledge is quite rudimentary; moreover, many areas that in general are well understood contain gaps or unresolved controversy (e.g. the health impacts of low-level radiation). Thus given the present state of the art(s), risk assessments tend to be either speculative, biased in favor of known areas, or both.

Decisions on risk made in a societal context are reacted to in an individual context. There is ample evidence that individual evaluations of risk differ markedly from evaluations made in the name of society as a whole. This is so in part because societal risk is derived from an objective function comprised of the value of each consequence and its probability, while individuals rely for the most part on subjective intuition; and in part because in a societal context, risk is assessed in terms of its net magnitude, while individuals respond more to its distribution.

THE INDIVIDUAL-SOCIETAL DISPARITY

This individual-societal disparity may in fact be the most intractable obstacle to the use of risk assessment in decisions. Unlike the two previously mentioned, it can not be ameliorated by experimental results or improved analytic methods; nor can the behavior of either set of actors be easily changed. The individual upon whose risk is imposed can hardly be expected not to care how the risk is distributed; nor can the typical individual be counted on to face personal risk with no emotional bias. Yet society may have no alternative but to be neutral on both counts. The egalitarian ideal our society operates under tends to get in the way of any evaluation of distribution (who is to be favored and who is not?); and the emotional biases we have as individuals are often not true reflections but distortions of reality, and would lead to suboptimal decisions. On the other hand, even if it may not be feasible nor desirable to incorporate the above considerations into policy decisions, it is clear from experience they are crucial to the viability of any policy, and thus must be recognized and dealt with at some point. The near-stagnation of the nuclear industry in the U.S. is a prime example of the consequences of ignoring (even ridiculing) the disparity between societal and individual views of risk. The individual view can only be expected to receive far more scrutiny in future energy-related decisions, and this in turn will undoubtedly influence the development of the art of risk assessment.

DISTRIBUTION OF RISK

One of the most familiar examples of the impact of distribution on risk perception is the dialogues that went on in family rooms all over the country between fathers and their draft-age sons during the Vietnam war. My trump card on the anti-war side, of course, was that I could get blown up over there; my father's inevitable response was that I could also get run over by a truck tomorrow. What struck me most about this oblique response was not its blunt stoicism, but rather that everyone of draft age I knew got almost identical responses from their fathers. Remarkably, from a societal point of view, their assessment was fairly close to the mark: at the time (1968) the risk of death for society as a whole was not much greater from the war than it was from motor vehicle accidents. However, for those of us of draft age, the risk of death in Vietnam was about an order of magnitude greater than the normal mortality rate (Starr, 1969) and that is what governed our response.

The point of this story is that "societal risk" is a fiction: almost any risk imaginable is, in a society as large and diverse as ours, bound to be non-uniform to some extent. This fiction may be a necessary one in order for society to run and decisions to be made; but it is naive to expect those on whom the most risk is imposed to comply with equanimity, unless the potential benefits are perceived to more than compensate for the risk.

Benefits are the other side of the distribution question; yet, they are often ignored in risk assessment, despite evidence that how a risk is perceived is influenced by the value of the benefits it entails (Starr, 1969; Fischoff et al., 1978). Individuals believe that, as long as risk is kept within certain limits, greater risks should be tolerated for more beneficial activities. Furthermore, for a given level of benefit, greater risk should be tolerated for voluntary than for involuntary activities (Fischoff et al., 1978). Unfortunately, in the case of synfuels, and many other "new" energy technologies, risk (personal and environmental) is concentrated in the region of production; on the other hand the benefitors, namely the consumers of the resources extracted or power generated, live almost entirely outside the region, in metropolitan areas up hundreds of miles distant. The only benefits those who bear the risk receive are the new jobs created; and in reality this often turns out to be a curse in disguise (the "boomtown" effect).

QUIRKS OF INTUITION

Confronted with risk, individuals rely not on quantitative methods and the laws of probability, but on subjective judgements, based on a set of inferential rules known as heuristics. Since most people are unfamiliar with either of the former, this is hardly a surprise. Yet such heuristics lead both to biases in favor of certain types of risk over others, and also to systematic mistakes in estimating probability.

Personal control vs external control. Individuals as a rule tolerate much greater risk in activities over which they exert personal control than in those over which control is in the hands of some external body. The discrepancy in the public's view of automobile and airplane travel is an oft-cited example; people tend to intuitively fear airplanes more than automobiles, yet the former mode of travel is safer (Starr and Whipple, 1980). This bias is understandable as an outcome of the societal-individual disparity: the individual may perceive, consciously or unconsciously, that activities under personal and external control are respectively governed by individual and societal views of risk. Whereas in the former case the individual's own life is of infinite value, in the societal contect no life has an infinite value, and the main consideration is saving the greatest net number of lives, even at the expense of a few. Since, in any activity under external control, there is always the potential the individual may become one of the expendable few, s/he tends to be far more skeptical of any risk they pose, factual historical data notwithstanding.

Incremental vs catastrophic events. Individuals also tend to be more favorably disposed to consequences that are distributed over time than to those where a lot of people get it at once. This bias may be due in part to the fact that catastrophes tend to be low-probability, and low-probability events tend to be overestimated (see below); but other heuristics may also be at work. For one thing, most people value (positively or negatively) near-term events more highly than ones more distant in the future. Thus, whereas incremental events represent a stream discounted over time, the potential catastrophe could happen tomorrow, and since one's life is at stake this "worst case" may comprise the basis for evaluation. Another potential factor is that the more a set of events is distributed over time, the more likely a means to prevent or reverse them may develop.

Insensitivity to prior probability. Where historical risk data exists, the base-rate frequency of an outcome should be a major factor in an assessment of its future risk. This seems obvious, yet experiments have repeatedly shown that individuals tend to ignore such data except in the absence of any other data. Kahneman and Tversky (1973), for example, set up an experiment wherein subjects were told a certain group was composed of 70 engineers and 30 lawyers; in the absence of any other information, the subjects correctly assessed the probability a given member was an engineer as .7. However, a "personality sketch" of the member was then introduced, designed to convey no information whatsoever relevant to his vocation. Armed with this worthless additional information, the probability of his being an engineer was judged to be .5.

Insensitivity to sample size. Experiments have also demonstrated that individual estimates of probability tend to disregard the size of the sample from which base-rate data are drawn. For example, in one experiment the probability of an average height greater than 6 ft was judged to be the same for samples of 1000, 100, and 10 men; in another, the probability that 60% or more of all births in a day would be boys was judged to be the same for a large and a small hospital (Tversky and Kahneman, 1972). In both instances, of course, deviations from the mean are far more likely in the small sample; and conversely, the larger samples are more representative of the whole from which they are drawn. This fundamental reality is evidently absent from individuals' risk evaluations.

Retrievability of instances. An event may be more "retrievable" because its instances are more salient or more recent, or both, than other events'; and the more retrievable an event, the greater its intuited probability. For example, the intuited probability of home fires tends to rise temporarily after the house down the block burns. This heuristic often combines with insensitivity to sample size to produce overestimates of probability based on single, but very retrievable, events such as the Three Mile Island incident. In fact, of course, single events prove almost nothing about probability beyond the fact that the risk is not zero.

Ovestimation of low-probability events. Experiments have repeatedly demonstrated that very low probability events seem more likely than they are in fact; in other words, a 10^{-6} risk does not seem only a thousandth as likely as a 10^{-3} risk (Mishan, 1976). As a result, people tend to overestimate the probability of such events. One reason for this bias may be that, once probability declines below the range in which it is intuitively understandable, people are not as confident in their ability to discriminate, and thus err in the "conservative" direction. The nature of the consequence also seems to play a role, however. In risk assessment, low-probability events also tend to be the most catastrophic; and Lichtenstein et al. (1978) found that, when subjects were asked to estimate the probability of various causes of death, low-probability events were overestimated, but that in experiments with neutral objects, such as word frequency in a list, this bias does not show up.

A special type of overestimation, and one with an apparently different source, is that related to conjunctive events, i.e. events composed of serial subevents. In such events, even when the probability of each discrete subevent is comparatively high, their product, the overall probability, can be quite low if the set of subevents is large. Yet experiments show people tend to subjectively overestimate the probability of conjunctive events (Cohen et al., 1974) and, conversely, underestimate disjunctive events. This is due to an heuristic bias known as anchoring: in an estimation procedure that begins with some value, any value, that is then adjusted or manipulated to yield the final answer, individuals tend to bias the answer toward the initial value (Tversky and Kahneman, 1974). In the case of conjunctive events, the high probability figures for the discrete subevents are the anchoring point. The obvious relevance of this heuristic is that, in systems where multiple safety devices must all fail in order for a catastrophe to occur, the lay public may be expected to be considerably more skeptical of those devices than the engineers. The evidently divergent views of "experts" and the public toward the risk of meltdown in nuclear plants is a case in point.

IMPLICATIONS FOR RISK ASSESSMENT

In sum, to contrast the individual and societal views of risk, the typical individual may be expected to respond more negatively to potential consequences that:

- are under external control,
- are low-probability but catastrophic in nature,
- require a conjunctive sequence of subevents, and
- have recent and/or salient instances.

Moreover, the individual will be less influenced, if at all, by:

- the size of the sample for those instances, or
- their overall base-rate frequency.

Lest any doubt exist as to the power of the individual view in the political arena, consider the risk of death from radiation exposure due to a nuclear accident vs. that from a motor vehicle accident. In the nuclear case, control is external; the event is low-probability but catastrophic (i.e. many victims are involved per event); it requires a sequence of failures; and it has had a lot of publicity recently. On the other hand, at least so far such accidents have been isolated events, and their base-rate frequency remains low. Motor vehicle accidents are near the opposite end of every one of the above spectra: they are, for the most part, under personal control; they are comparatively high-probability but incremental; and so on. It is undoubtedly no coincidence that the U.S. presently spends about $140,000 to save a person from death on the road, and about $5,000,000 to save her/him from death due to radiation exposure (Howard et al., 1978).

Nuclear risk aversion is reinforced by the distribution of benefits. The capacity of nuclear plants is so large that most of their benefits, namely the power generated, inevitably flow outside the region put at risk. In the case of motor vehicles, on the other hand, the benefits go mostly to the driver, in the form of personal mobility.

I have presumed in advance that most of the work presented here would deal in one way or another with improving either the methodology of risk assessment itself, or the analytic techniques required to provide data for it. The point of my own talk is simply that intractable obstacles to the use of risk assessment in policymaking exist outside the state of the art. In the above example, for instance, it is hard to imagine how any societal risk assessment would not identify nuclear power as the lower risk. Yet informed lay people are consistently at variance with "experts" on this, and many other, types of risk (Fischoff et al., 1978).

Risk assessment has a long way to go before it is able to inspire any confidence on the part of the policymaker. To develop it to that point requires not only time but a substantial diversion of research funds away from more basic analyses of environmental impacts, in order to quantify the probabilities of those impacts for various technologies. In view not only of the uncertainty of ascertaining those probabilities in the first place, but also, given the problems described in this paper, of their questionable utility in the real political world, it is certainly valid to ask whether comparison of risk should be pursued at all.

In the end it may be far more feasible, as a number of observers have proposed (Comar, 1979; Batta Gori, 1980; House, 1980), for society to define *de minimis* standard for risk, and compare technologies on the basis of demonstrable ability to meet those standards at least cost. The development of those standards would, of course, take place in the political arena, and would undobtedly be far less elegant than quantitative analyses performed by a technical elite. But the results would at least reflect the way humans perceive risk in the real world.

> Indeed, the current regulatory process may be in disfavor because it is not honesly judgmental and, by insisting on inadequate science and intransigent ideals, produces results that are perceived at times as arbitrary, inconsistent, or unacceptable to the public at large. The central point of procedural reform is that resolution of uncertainties must be attempted in an open sociopolitical context, because utility, benefit, tolerablé hazard, and safety cannot be defined on the independent authority of scientific facts or statutory prerogative (Batta Gori, 1980).

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